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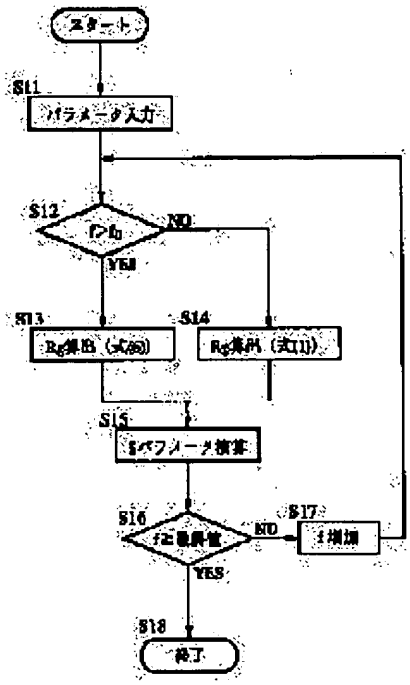
(54) METHOD, AND ITS DEVICE FOR SIMULATING CIRCUIT OF FIELD EFFECT TRANSISTOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a circuit simulation method for calculating the frequency characteristics of a field effect transistor using an equivalent circuit in which the characteristics of field effect transistor can be represented highly accurately even in high frequency region.

SOLUTION: In the circuit simulation method for calculating the frequency characteristics of a field effect transistor using an equivalent circuit, resistance of gate electrode is calculated while taking account of effective decrease of cross-sectional area of a gate electrode due to skin effect in high frequency region and then the frequency characteristics of the field effect transistor are calculated using the resistance of gate electrode.



LEGAL STATUS

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[Patent number]

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CLAIMS

[Claim(s)]
[Claim 1] The circuit simulation approach of the field-effect transistor characterized by being the circuit simulation approach of the field-effect transistor which computes the frequency characteristics of a field-effect transistor using an equal circuit, computing the resistance of said gate electrode in consideration of reduction of the effectual cross section of the gate electrode by the skin effect in a RF field, and calculatin the frequency characteristics of said field-effect transistor using the resistance of said gate electrode.
[Claim 2] It is the circuit simulation approach of the field-effect transistor characterized by computing base on the function containing the permeability of the ingredient with which the resistance of said gate electrod constitutes said gate electrode in the circuit simulation approach of a field-effect transistor according to cla 1, the specific resistance of the ingredient which constitutes said gate electrode, the thickness of said gate electrode, and the width of face of said gate electrode.
[Claim 3] In the circuit simulation approach of a field-effect transistor according to claim 2 said function Thickness of the field where w and a current flow [specific resistance / of the ingredient which constitutes mu and said gate electrode for the permeability of the ingredient which constitutes Rg and said gate electrode for the resistance of said gate electrode] the width of face of t and said gate electrode in the thickness of rho and said gate electrode is set to delta. Rg=Rg0wt/(2 (t+w)) x (delta+2/per /(t+w-2delta)) The circuit simulation approach of the field-effect transistor characterized by what it is alike and is express more.
[Claim 4] It is the circuit simulation approach of the field-effect transistor characterized by being the equal circuit where said equal circuit was described by the concentrated constant in the circuit simulation approa of a field-effect transistor given in claim 1 thru/or any 1 term of 3.
[Claim 5] It is the circuit simulation approach of the field-effect transistor characterized by being the equal circuit where, as for said equal circuit, at least one of a gate electrode, a drain electrode, or the source electrodes was described by the distributed constant in the circuit simulation approach of a field-effect transistor given in claim 1 thru/or any 1 term of 3.
[Claim 6] It is circuit simulation equipment of the field-effect transistor which computes the frequency characteristics of a field-effect transistor using an equal circuit. A means to store the program which computes the resistance of said gate electrode in consideration of reduction of the effectual cross section the gate electrode by the skin effect in a RF field, Circuit simulation equipment of the field-effect transistor characterized by having a means to read and perform said program and to compute the gate electrode of said gate electrode, and a means to compute the frequency characteristics of said field-effect transistor based on the resistance of said gate electrode.
[Claim 7] The circuit simulation model of the field-effect transistor characterized by using the value which i the circuit simulation model of the field-effect transistor for computing the frequency characteristics of a fie effect transistor using an equal circuit, and took into consideration reduction of the effectual cross-sectiona area of the gate electrode by the skin effect in a RF field as resistance of the gate electrode of said field-effect transistor.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the circuit simulation of the field-effect transistor which computes the frequency characteristics of a field-effect transistor using an equal circuit, and relates to the circuit simulation approach and equipment list of a field-effect transistor which can express the property of field-effect transistor with high precision also in a high frequency field especially at a circuit simulation model.
[0002]
[Description of the Prior Art] The semiconductor device constituted by the compound semiconductor is widely used for the product for which high frequency operation and high-speed operation are mainly need using the high electron mobility which a compound semiconductor has. As a compound semiconductor element, the transistor of electric field effect molds, such as MESFET and HEMT, is known widely conventionally, and constituting a large-scale high integrated circuit and a RF circuit in recent years using these field-effect transistors is examined.
[0003] When designing the large-scale high integrated circuit and high frequency circuit containing such a field-effect transistor, designing the whole circuit using the simulation model for expressing the measured value of the frequency characteristics (for example, S parameter) of a field-effect transistor is performed. F this reason, it is very important when how the simulation model which reproduces the frequency characteristics of a field-effect transistor faithfully is built designs a large-scale high integrated circuit and a RF circuit.
[0004] Conventionally, in order to express the frequency characteristics of a field-effect transistor, the concentrated-constant mold equal circuit and the distributed constant mold equal circuit in consideration o the die length of an electrode are used widely. As shown, for example in drawing 5 , in a concentrated-constant mold equal circuit Gate resistance Rg, The drain resistance Rd, source resistance Rs, the gate inductance Lg, the drain inductance Ld, The source inductance Ls, the capacity Cgd between gate-drains the capacity Cgs between the gate-sources, The capacity Cds between source-drains, drain conductance Gd, a mutual conductance Gm, The channel resistance Ris constitutes a model circuit, as it is doubled an crowded in the actual measurement of the electric field effect effectiveness transistor, these variable value are determined, and the S parameter of a field-effect transistor is computed from these.
[0005] As shown, for example in drawing 6 , in a distributed constant mold equal circuit The gate resistanc Rg0 per unit length, the drain resistance Rd0 per unit length, source resistance Rs, The gate inductance L per unit length, the drain inductance Ld0 of the die length per unit, the source inductance Ls, Y parameter of the intrinsic region per unit length, The capacity Cgd0 between gate-drains per unit length, the capacity Cgs0 between the gate-sources per unit length, the capacity Cds0 between source-drains per unit length, the drain conductance gd0 per unit length, the mutual conductance gm0 per unit length, The channel resistance Ris0 per unit length constitutes the model circuit containing a distributed constant. As it is doubled and crowded in the actual measurement of the electric field effect effectiveness transistor, these variable values are determined, and the S parameter of a field-effect transistor is computed from these (about **** circuits, such as a distributed constant). For example S. J.Nash and A.Platzker, and W.Struble and "Distributed small signal model for Refer to multifingered GaAs PHEMT/MESFET devices", IEEE Microware and Millimeter-Wave Monolithic Circuits Symposium, and 1996.
[0006] Moreover, the experiential function which has frequency dependent in the gate resistance Rg of ***

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circuits, such as the above-mentioned concentrated-constant mold equal circuit or the above-mentioned distributed constant, is applied, and the circuit simulation model which can express the frequency characteristics of a field-effect transistor to accuracy more is also proposed. As an experiential function which gave frequency dependence to gate resistance Rg, it is Rg=R0xcosh (Rsexf), for example, using f a a frequency by using R0 and Rse into a constant.
The function with which it is alike and is expressed more is applied.
[0007]
[Problem(s) to be Solved by the Invention] However, the simulation model using **** circuits, such as a concentrated-constant mold equal circuit, a distributed constant, etc. of the above-mentioned former, was what is not taken into consideration about the effect in a RF, but lacks in the precision in a RF field. Moreover, although the property of a field-effect transistor was reproducible up to a certain amount of frequency domain in the simulation model which gave frequency dependent to gate resistance Rg, the above-mentioned function does not have a physical background, on the frequency of 50GHz or more, the error was produced [experiential] to the actual transistor, and precision was getting worse.
[0008] The purpose of this invention is to provide with a circuit simulation model the circuit simulation approach and equipment list of a field-effect transistor which may approximate the property of a field-effec transistor with a sufficient precision also in a frequency domain 50GHz or more.
[0009]
[Means for Solving the Problem] The above-mentioned purpose is the circuit simulation approach of the field-effect transistor which computes the frequency characteristics of a field-effect transistor using an equ circuit, computes the resistance of said gate electrode in consideration of reduction of the effectual cross section of the gate electrode by the skin effect in a RF field, and is attained by the circuit simulation approach of the field-effect transistor characterized by calculating the frequency characteristics of said fiel effect transistor using the resistance of said gate electrode. Thus, since the resistance of the computed ga electrode is taking into consideration the physical effectiveness of the skin effect in a RF field, it can approximate the frequency characteristics of a field-effect transistor with a more sufficient precision by the experiential component as compared with the conventional method of performing doubling **** of the resistance of a gate electrode.
[0010] Moreover, you may make it compute the resistance of said gate electrode in the circuit simulation approach of the above-mentioned field-effect transistor based on the function containing the permeability the ingredient which constitutes said gate electrode, the specific resistance of the ingredient which constitutes said gate electrode, the thickness of said gate electrode, and the width of face of said gate electrode. In the circuit simulation approach of the above-mentioned field-effect transistor moreover, said function Thickness of the field where w and a current flow [specific resistance / of the ingredient which constitutes mu and said gate electrode for the permeability of the ingredient which constitutes Rg and said gate electrode for the resistance of said gate electrode] the width of face of t and said gate electrode in th thickness of rho and said gate electrode is set to delta. You may make it Rg=Rg0wt/(2 (t+w)) x (delta+2/pe (t+w-2delta)) express.
[0011] Moreover, in the circuit simulation approach of the above-mentioned field-effect transistor, said equ circuit can apply the equal circuit described by the concentrated constant. Moreover, in the circuit simulati approach of the above-mentioned field-effect transistor, said equal circuit can apply the equal circuit wher at least one of a gate electrode, a drain electrode, or the source electrodes was described by the distribute constant.
[0012] Moreover, the above-mentioned purpose is circuit simulation equipment of the field-effect transistor which computes the frequency characteristics of a field-effect transistor using an equal circuit. A means to store the program which computes the resistance of said gate electrode in consideration of reduction of th effectual cross section of the gate electrode by the skin effect in a RF field. A means to read and perform said program and to compute the gate electrode of said gate electrode, It is attained by the circuit simulati equipment of the field-effect transistor characterized by having a means to compute the frequency characteristics of said field-effect transistor based on the resistance of said gate electrode.
[0013] Moreover, the above-mentioned purpose is the circuit simulation model of the field-effect transistor computing the frequency characteristics of a field-effect transistor using an equal circuit, and is attained by the circuit simulation model of the field-effect transistor characterized by using the value which took into consideration reduction of the effectual cross-sectional area of the gate electrode by the skin effect in a RF

field as resistance of the gate electrode of said field-effect transistor.
[0014]
[Embodiment of the Invention] The circuit simulation approach and circuit simulation model of a field-effec transistor by 1 operation gestalt of this invention are explained using drawing 1 thru/or drawing 6 . The outline sectional view where drawing 1 explains the structure and the skin effect of a field-effect transistor, the flow chart which shows the circuit simulation approach according [drawing 2] to this operation gestalt the graph with which drawing 3 shows frequency dependent [of the S parameter of a field-effect transisto the block diagram showing circuit simulation equipment according [drawing 4] to this operation gestalt, drawing in which drawing 5 shows the concentrated-constant mold equal circuit of a field-effect transistor, and drawing 6 are drawings showing the distributed constant mold equal circuit of a field-effect transistor.
[0015] First, the circuit simulation model by this operation gestalt is explained using drawing 1 . The structure shown in drawing 1 is assumed in construction of a circuit simulation model as general structure the field-effect transistor which consists of compound semiconductors, such as MESFET and HEMT. That the field-effect transistor which has the gate electrode 16 of T mold which consists of a contact field 12 in contact with the semi-conductor substrate 10 and a wiring field 14 formed on the contact field 12 is considered.
[0016] In a direct current or a low frequency field, the current which flows the gate electrode 16 flows to homogeneity in the cross section of the gate electrode 16. Moreover, gate resistance is determined by resistance of the wiring field 14. Therefore, when S and thickness are set to t and specific resistance of w and a gate electrode material is set [the cross section of a wiring field] to rho for width of face, the gate resistance Rg0 per unit length is Rg0=rho/S=rho/(txw). -- (1)
It is expressed by carrying out.
[0017] On the other hand, it will be known that the skin effect will generally show up in a RF field, a curren will flow only in the surface field of the gate electrode 16 in a RF field, and a current will not flow inside the gate electrode 16. Thickness delta of the field where a current flows sets the specific resistance of a gate electrode material, and a frequency to f, and sets [mu] a circular constant to pi for permeability and rho.
delta=(2pimuf/2rho)-1/2 =Axf-1/2 (however, A=(rho/pimu) 1/2) -- (2)
It is expressed by carrying out.
[0018] Therefore, if w>t, the field where a current does not flow at the time of delta>=0.5xt is not generate but gate resistance Rg is equivalent to direct current resistance Rg0. Namely, Rg=Rg0 -- (3)
It becomes. On the other hand, when it comes to delta<0.5xt, as shown in drawing 1 (b), the field 18 wher a current does not flow is formed, and gate resistance Rg increases. Namely, the cross section Sf of the field where a current flows Sf=wt-(t-2delta) x (w-2delta) -- (4)
Since be alike is given, gate resistance Rg is Rg=Rg0xS/Sf. -- (5)
It becomes. If thickness [of the field where the current of a formula (1) flows] delta, thickness [of the gate electrode 16] t, and width of face w express the cross sections S and Sf of a formula (4) and they are rewritten Rg=Rg0wt/(2 (t+w))
x (delta+2/per /(t+w-2delta)) -- (6)
It becomes.
[0019] A formula (6) gives the gate resistance Rg in consideration of the physical effectiveness of the skin effect in a RF field including the specific resistance rho of permeability mu and a gate ingredient, thickness [of the gate electrode 16] t, width of face w, and a frequency f. Therefore, as compared with the conventional method of performing doubling **** of gate resistance, the S parameter of a field-effect transistor can be approximated with a more sufficient precision by the experiential component by asking fo the S parameter of a field-effect transistor using the gate resistance Rg for which it asked by the formula (by the concentrated-constant mold equal circuit or the distributed constant mold equal circuit.
[0020] In addition, a formula (6) is a function containing the square root of a frequency, and is considered be what has desirable expressing gate resistance with the function of the square root of a frequency as a model showing the skin effect in a high frequency field. Next, the circuit simulation approach using the above-mentioned circuit simulation model is explained using drawing 2 .
[0021] Drawing 2 is a flow chart which shows the circuit simulation approach by this operation gestalt whic CPU performs using the circuit simulation model expressed by the formula (6). First, the specific resistanc rho of a gate ingredient, thickness [of a gate electrode] t, width of face w, and permeability mu are inputte as a parameter required for the operation of gate resistance Rg. Moreover, parameters other than gate

resistance Rg required for count of the S parameter of a field-effect transistor are also inputted (step S11)
[0022] Next, based on the above-mentioned input parameter, the frequency f0 which the skin effect generates is computed. A frequency f0 is given as a frequency set to delta= 0.5t in a formula (2). Therefor a frequency f0 is from a formula (2). f0=rho/(pimudelta2) =rho/(0.25xpimut2) -- (7)
It becomes.
[0023] Next, the size of the frequency f and frequency f0 to calculate is compared (step S12). Next, the formula of gate resistance Rg is chosen based on the size of a frequency f and a frequency f0. When a frequency f is f≥f0 (i.e., when the skin effect has occurred), gate resistance Rg is computed by the formula (6) (step S13). When a frequency f is f<=f0 (i.e., when the skin effect has not occurred), gate resistance R is computed by the formula (1) (step S14).
[0024] Next, the S parameter of a field-effect transistor is calculated using the gate resistance Rg called fo by step S13 or step S14 (step S15). For example, a concentrated-constant mold equal circuit (drawing 5 and a distributed constant mold equal circuit (drawing 6) can be used for the operation of an S paramete For example, according to the distributed constant mold equal circuit shown in drawing 6 , gate voltage Vg and the drain electrical potential difference Vd are given with the following 2 class differential equation.
[0025] d2Vg/dx2= (Rg(f)+jomegaLg) (Y11Vg(x)+Y12Vd(x))
d2Vd/dx2= (Rd+jomegaLd) (Y21Vg(x)+Y22Vd(x))
Here, Yij is the Y parameter of the intrinsic region per unit gate width. Therefore, the S parameter of a field effect transistor is computable by calculating using the above-mentioned equation and predetermined boundary condition.
[0026] Next, it distinguishes whether the frequency f which calculated the S parameter is more than a fina value (step S16). If a frequency f is not more than a final value, only a predetermined value will increase a frequency f only by 1GHz, it will progress to S12, and the above-mentioned steps S12-S16 will be repeate (step S17). Data processing is ended when a frequency f is more than a final value (step S18).
[0027] Thus, frequency dependent [of the S parameter in consideration of the skin effect in the RF field of field-effect transistor] is computable. Drawing 3 is a graph which shows frequency dependent [of the S parameter (S11 component) of a field-effect transistor]. The continuous line shows the actual measureme for the calculated value at the time of using the conventional circuit simulation model which expresses gat resistance Rg for calculated value when an alternate long and short dash line uses the circuit simulation model by this operation gestalt using a function with an experiential dotted line among drawing.
[0028] In addition, gate length is [0.15 micrometers and gate width] 80 micrometers, and, as for the actua measurement, the supply layer used HEMT from which the InGaP layer and the channel layer were constituted by the InGaAs layer. The vector network analyzer made from Hewlett Packard measurable to 75GHz was used for measurement of frequency characteristics. The Measuring condition was set to Vds=2V and Vgs=-0.6V.
[0029] Although it can approximate with a precision sufficient [about 30GHz] when the conventional circu simulation model is used so that it may illustrate, above about 30GHz, the error is large. On the other han when the circuit simulation approach by this operation gestalt was used, even the frequency of about 60G or more was able to be approximated with a sufficient precision. Next, an example of the circuit simulation equipment for realizing the circuit simulation approach by this operation gestalt is explained using drawing 4 .
[0030] Drawing 4 is the block diagram showing the circuit simulation equipment by this operation gestalt. Each equipment is connected to the common bus line 20 with the circuit simulation equipment by this operation gestalt. CPU22, ROM24 for storing a control program, RAM26 in which the program for perform the circuit simulation approach was stored, the display unit 28, the printer 30, and the disk unit 32 are connected to the bus line 20.
[0031] Next, actuation of the circuit simulation equipment by this operation gestalt is explained. First, the circuit simulation program which performed the control program stored in ROM24, and controlled the whol system by CPU22, for example, was stored in the disk unit 32 is read, and it stores in RAM26. A circuit simulation program is a program which performs the flow chart of the circuit simulation approach by this operation gestalt shown in drawing 2 .
[0032] Next, the control program stored in ROM24 is performed by CPU22, the whole system is controlled and the circuit simulation program stored in RAM26 is performed. The variable used for program executio can be obtained by inputting from the keyboard which is not illustrated for example, or reading from a disk

unit 32. In addition, RAM26 is used also as a working area.
[0033] Next, the control program stored in ROM24 is performed, the whole system is controlled by CPU22 and the program which computes the S parameter of a field-effect transistor based on a concentrated-constant mold equal circuit or a distributed constant mold equal circuit is read from a disk unit 32, and is stored in RAM26. Next, the control program stored in ROM24 is performed, the whole system is controlled by CPU22, the program for computing the S parameter stored in RAM26 is performed, referring to the resistance of the gate electrode given by the program which performs the flow chart of the circuit simulatio approach by this operation gestalt, and the S parameter of a field-effect transistor is computed.
[0034] Next, the simulation result obtained by the circuit simulation program is stored in a disk unit 32. A simulation result is displayed on a display unit 28 after simulation termination, and a printout is carried out from a printer 30 if needed. By carrying out like this, circuit simulation using the circuit simulation model by this operation gestalt can be performed.
[0035] Thus, since according to this operation gestalt gate resistance Rg asks in consideration of the skin effect in a RF field and it asks for the S parameter of a field-effect transistor based on this value, as compared with the conventional method of performing doubling **** of gate resistance, the S parameter of field-effect transistor can be approximated with a more sufficient precision by the experiential component.
[0036] Not only the above-mentioned operation gestalt but various deformation is possible for this inventio For example, with the above-mentioned operation gestalt, when asking for the S parameter of a field-effec transistor, the example using the distributed constant mold equal circuit shown in the concentrated-consta mold equal circuit shown in drawing 5 or drawing 6 was shown, but if it is an equal circuit using gate resistance Rg, it is applicable to any of other equal circuits.
[0037] Moreover, in the distributed constant mold equal circuit shown in drawing 6 , although the distribute constant expresses the gate electrode (gate resistance Rg, gate inductance Lg) and the drain electrode (t drain resistance Rd, drain inductance Ld), a distributed constant may express a source electrode (source resistance Rs, source inductance Ls). Moreover, a distributed constant may express any one of a gate electrode, a drain electrode, and the source electrodes, or two.
[0038] Moreover, although the above-mentioned operation gestalt showed the case where this invention w applied to the gate electrode of T mold, it is also applicable to the gate electrode of other structures. Moreover, this invention makes it a fundamental concept to make the skin effect in a RF field reflect in gat resistance Rg, and the equipment shown in the flow chart shown in drawing 2 or drawing 4 is not limited to these.
[0039]
[Effect of the Invention] In the circuit simulation approach of the field-effect transistor which computes the frequency characteristics of a field-effect transistor using an equal circuit according to this invention the above passage By computing the resistance of a gate electrode in consideration of reduction of the effectu cross section of the gate electrode by the skin effect in a RF field, and calculating the frequency characteristics of a field-effect transistor using the resistance of a gate electrode Since the physical effectiveness of the skin effect in a RF field is taken into consideration, as compared with the conventiona method of performing doubling **** of the resistance of a gate electrode, the frequency characteristics of a field-effect transistor can be approximated with a more sufficient precision by the experiential component.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is an outline sectional view explaining the structure and the skin effect of a field-effect transistor.
[Drawing 2] It is the flow chart which shows the circuit simulation approach by 1 operation gestalt of this invention.
[Drawing 3] It is the graph which shows frequency dependent [of the S parameter of a field-effect transistor].
[Drawing 4] It is the block diagram showing the circuit simulation equipment by 1 operation gestalt of this invention.
[Drawing 5] It is drawing showing the concentrated-constant mold equal circuit of a field-effect transistor.
[Drawing 6] It is drawing showing the distributed constant mold equal circuit of a field-effect transistor.
[Description of Notations]
Rg -- Gate resistance
Rd -- Drain resistance
Rs -- Source resistance
Lg -- Gate inductance
Ld -- Drain inductance
Ls -- Source inductance
Cgs -- Capacity between the gate-sources
Cgd -- Capacity between gate-drains
Cds -- Capacity between the drain-sources
gd -- Drain conductance
gm -- Mutual conductance
Ris -- Channel resistance
10 -- Semi-conductor substrate
12 -- Contact field
14 -- Wiring field
16 -- Gate electrode
18 -- Field where a current does not flow
20 -- Bus line
22 -- CPU
24 -- ROM
26 -- RAM
28 -- Display unit
30 -- Printer
32 -- Disk unit

[Translation done.]

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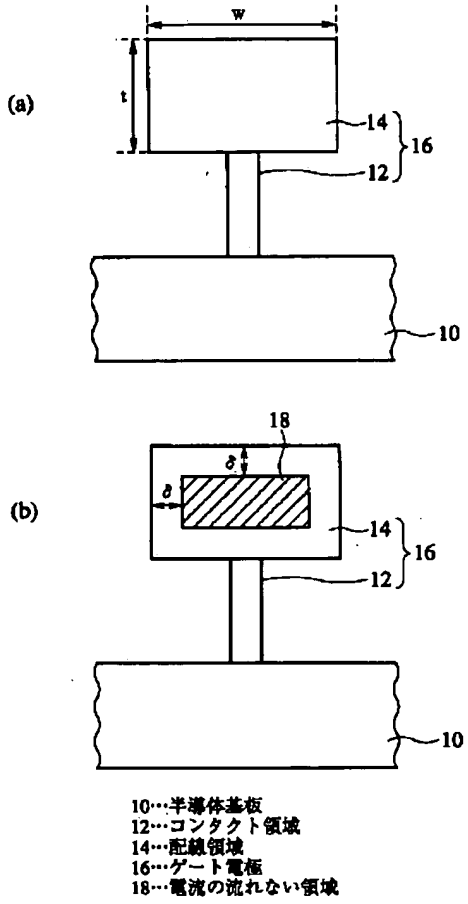
* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]

電界効果トランジスタの構造及び表皮効果を説明する
概略断面図



10…半導体基板
12…コンタクト領域
14…配線領域
16…ゲート電極
18…電流の流れない領域

[Drawing 2]

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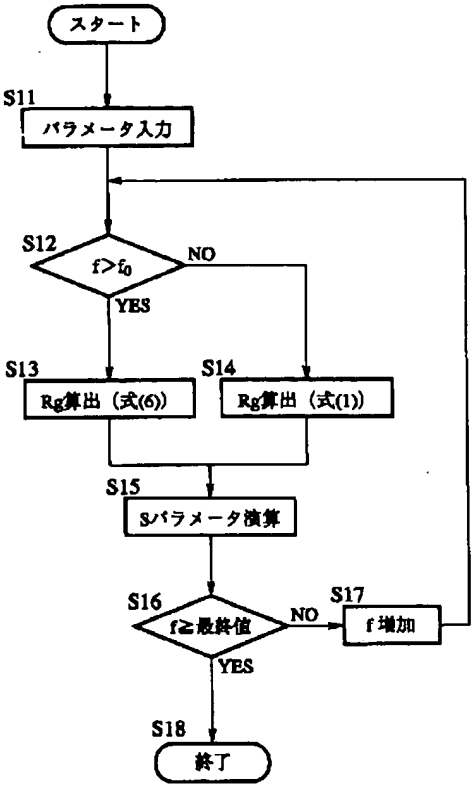
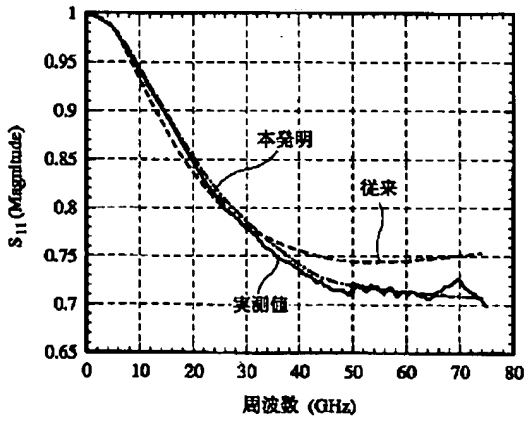
本発明の一実施形態による回路シミュレーション方法を示すフローチャート



[Drawing 3]

電界効果トランジスタのSパラメータの周波数依存性を示すグラフ



[Drawing 4]

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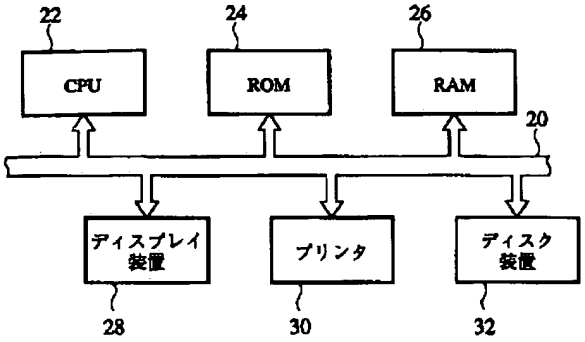
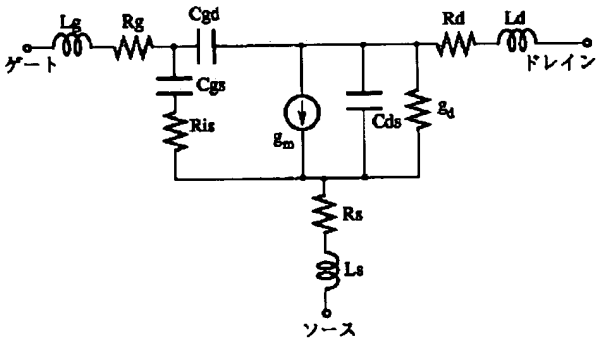
本発明の一実施形態による回路シミュレーション装置を示すブロック図



20…バスライン
22…CPU
24…ROM
26…RAM
28…ディスプレイ装置
30…プリンタ
32…ディスク装置

[Drawing 5]

電界効果トランジスタの集中定数型等価回路を示す図



Rg…ゲート抵抗
Rd…ドレイン抵抗
Rs…ソース抵抗
Lg…ゲートインダクタンス
Ld…ドレインインダクタンス
Ls…ソースインダクタンス
Cgs…ゲート－ソース間容量
Cgd…ゲート－ドレイン間容量
Cds…ドレイン－ソース間容量
g_d…ドレインコンダクタンス
g_m…相互コンダクタンス
Ris…チャネル抵抗

[Drawing 6]

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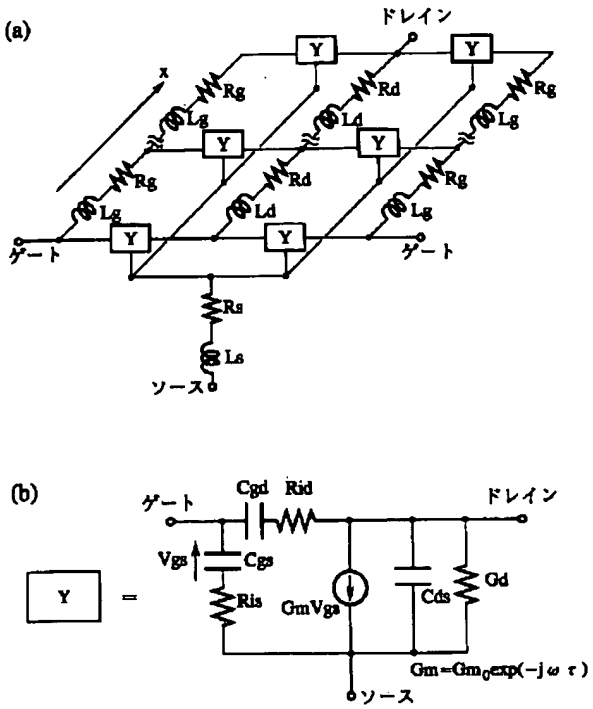
電界効果トランジスタの分布定数型等価回路を示す図



Rg…ゲート抵抗
Rd…ドレイン抵抗
Rs…ソース抵抗
Lg…ゲートインダクタンス
Ld…ドレインインダクタンス
Ls…ソースインダクタンス
Cgs…ゲートーソース間容量
Cgd…ゲートードレイン間容量
Cds…ドレインーソース間容量
Gd…ドレインコンダクタンス
Gm…相互コンダクタンス
Ris…チャネル抵抗

[Translation done.]

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